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Published in:
Energy Research & Social Science

DOI:
10.1016/j.erss.2016.06.002

Energy Research & Social Science 20 (2016) 55–62

Contents lists available at ScienceDirect

Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss

Original research article

Is gas perceived as sustainable? Insights from value-driven evaluations in the Netherlands

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ARTICLE INFO

Article history:
Received 25 November 2015
Received in revised form 4 May 2016
Accepted 5 June 2016
Available online 19 June 2016

Keywords:
Public support
Sustainability claims
Values
Perceived environmental consequences

ABSTRACT

Various energy sources are positioned as sustainable, assuming this may elicit positive evaluations of these sources, particularly among people who care about nature and the environment (i.e. have strong biospheric values). For example, the gas industry and some politicians position gas as a relatively clean fossil fuel and as a transition fuel towards future sustainable energy systems. But will people, particularly those who strongly endorse biospheric values, positively evaluate every energy development that is promoted as sustainable? We studied how sustainability claims affect evaluations of gas in the Netherlands. In line with what is commonly stated in practice, in a scenario study, we either presented natural gas as a relatively clean fossil fuel in current energy systems, or as a transition fuel in future energy systems with an increased share of renewables. Interestingly, stronger biospheric values were not associated with more positive evaluations of natural gas in either of these conditions. Yet, the stronger their biospheric values, the more positively respondents evaluated gas innovations, namely green gas and power-to-gas, which do not rely on fossil fuels. The findings demonstrate that merely sustainability claims may not allay the concerns that people have about the environmental consequences of some energy developments.

1. Introduction

At the United Nations Climate Change Conference 2015 in Paris, countries across the world agreed to act towards reducing climate change [1]. Efficient use of less polluting energy sources are key actions in this respect [2]. Countries are debating to what extent different energy developments should play a role in future sustainable energy systems. Various energy sources, including renewable energy sources, nuclear power, natural gas, and unconventional gas and oil have been positioned in the energy market as (relatively) sustainable from an environmental point of view (e.g. low CO_2 emissions); we will label these arguments as sustainability claims in the remainder of this paper. But how do such sustainability claims affect people's evaluations of energy developments? This is an important question because energy futures depend largely on public evaluations and acceptability of the proposed energy developments [3,4]. Sustainability claims may particularly interest people who care about nature and the environment, that is, who strongly endorse biospheric values. Yet, even if people have strong biospheric values, will they give positive evaluations of any energy development that is promoted as sustainable? Below, we review literature on biospheric values and the relationships between these values and people's evaluations of energy developments, and propose boundary conditions under which strong biospheric values may or may not enhance positive evaluations of energy developments that are positioned as sustainable.

1.1. Values and evaluations of energy developments

Values are "desirable transsituational goals, varying in importance, that serve as guiding principles in the life of a person or other social entity" [5,p. 21]. Values are general overarching goals that may influence a wide range of beliefs, evaluations, and actions in many contexts [see [6,7] for reviews]. Values are therefore particularly interesting when studying people's evaluations of energy developments because, due to their overarching nature, values may influence evaluations of many different energy sources, systems, and policies [4,8]. People refer to their important values when evaluating objects [9]. Specifically, when evaluating a certain object, people focus on what implications it has for their important values. The stronger people endorse certain values, the more likely they are to refer to these values in their evaluations [10]. Contextual information, such as sustainability claims, make certain aspects of an object salient, which could imply that it is more likely that peo-

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http://dx.doi.org/10.1016/j.erss.2016.06.002

ple will base their evaluations on values that are related to these aspects [9].

Sustainability claims that stress the (positive) environmental consequences of energy developments are likely to be particularly important to people who strongly endorse biospheric values. Biospheric values focus people's concern on consequences for nature and the environment [6,7,10]. The stronger their biospheric values, the more motivated people are to act in a way that benefits (or causes the least damage to) the environment, and hence they may consider information that enables them to make environmentally-friendly choices. For example, when participants had to choose a restaurant for dinner, the stronger their biospheric values, the more they preferred restaurants that offer organic meals, rather than restaurants offering a lower price or tasty meals [11]. Similarly, literature suggests that the stronger their biospheric values, the more people focus on environmental consequences when evaluating energy developments. More specifically, values may determine how important people find different characteristics of energy developments. Indeed, the stronger people's biospheric values, the more importance they ascribed to environmental consequences of nuclear power and of renewable energy sources [12]. Further, people seem to favour energy developments that support their important values, and disfavour energy developments that threaten these values. For example, stronger biospheric values were associated with more positive evaluations of renewable energy sources that are generally seen as having positive (or less negative) environmental consequences (e.g. reducing CO_2 emissions). At the same time, stronger biospheric values were related to less positive evaluations of nuclear energy, which may be seen as hazardous for the environment [[12], see also [13–16]]. Furthermore, values may lead to overly positive or negative evaluations of energy developments on a wide range of characteristics, even if these characteristics are not very relevant to people given their values. For example, the stronger their biospheric values, the more positively people evaluated the economic benefits of wind energy for local communities [13] and the consequences of renewable energy sources for energy costs and people's daily comfort [12], even though these aspects are not key to them given their values.

The studies above suggest that the stronger their biospheric values, the more important people find environmental consequences of energy developments and the more positively they evaluate energy developments that (they believe) have positive environmental consequences. Stronger biospheric values may even lead to more positive evaluations of other characteristics of energy developments, such as price and quality of energy supply, if the energy developments are considered to be sustainable and therefore seen in an overly positive light by people with strong biospheric values. This is highly relevant, since some proposed sustainable energy developments, for example renewable energy sources, may be relatively expensive and the energy supply may be intermittent. People may support these energy developments despite such direct personal costs, if support is rooted in their biospheric values. The question remains, however, whether stronger biospheric values lead to more positive evaluations of any energy development that is promoted as sustainable.

1.2. Promoting energy developments as sustainable

Value theory implies that stronger biospheric values will lead to more positive evaluations of energy developments, the more these energy developments are seen as having positive implications for these values [6,7,10]. But what happens if an energy development is not seen as very sustainable, while it is nevertheless profiled as such? For example, nuclear power is positioned as a CO_2-neutral energy source and hence as relatively sustainable, yet people may be concerned about risks related to nuclear accidents and nuclear waste storage, and people seem reluctant to accept nuclear power as a solution to climate change [17]. Nuclear power is in fact evaluated least positively by people with strong biospheric values [12,15]. We propose that these findings can be explained as follows: although nuclear power is positioned as sustainable, people associate it with negative rather than positive environmental consequences. Stronger biospheric values therefore do not lead to more positive evaluations of nuclear energy, despite the sustainability claims; in fact, they may even lead to negative evaluations. This is noteworthy, since many energy developments are debatable with regard to how sustainable they actually are. Fossil fuels are generally seen by people as not sustainable from an environmental point of view [see [8], for a review]. For example, a study in the UK revealed that people consider energy developments that are associated with fossil fuels as "non-transitions" [18], and preliminary data in the Netherlands suggests that people make little distinction between different fossil fuels, namely oil and gas, and consider all fossil fuels to be dangerous, polluting, and increasing dependency on foreign countries [19]. Similarly, although it has been argued that power generation based on unconventional oil and gas is cleaner than coal-based power generation, people may nevertheless see unconventional hydrocarbons as not sustainable, because people associate them with, among others, ground water contamination, water scarcity, and seismic activity [20,21]. Because people primarily associate fossil fuels with negative environmental consequences, we hypothesize that promoting fossil fuels as sustainable will not trigger positive evaluations among people with strong biospheric values. We tested this proposition for natural gas in the Netherlands, as described below.

1.3. Value-driven evaluations of gas

Gas is an energy source that can be used for heating, cooking, and electricity generation. Natural gas forms the largest share of the total energy mix in the Netherlands and is the primary source for household energy use. Currently, mostly natural gas, which is a fossil fuel, is being used, and, to a smaller extent, bio-gas, which is produced from burning biodegradable products, such as plant and animal waste [22]. Gas is profiled as a relatively clean fossil fuel in the Netherlands because it emits little CO_2, and it is proposed that gas could serve as transition fuel to realise an energy system that merely relies on renewable energy sources [23]. Given such sustainability claims, how do people with strong biospheric values evaluate natural gas? On the one hand, the stronger people's biospheric values, the more they may appreciate the possibility that natural gas may be somewhat more sustainable than other fossil fuels and hence evaluate it positively. On the other hand, following our reasoning above, stronger biospheric values may not lead to more positive evaluations of natural gas if people see it as yet another fossil and expect primarily negative environmental consequences. We designed the current study to find out.

1.4. Current study

We presented two scenarios on the role of gas in energy systems, which included commonly used arguments to promote gas as a relatively sustainable fossil fuel. In the first scenario, we presented gas as a relatively clean fossil fuel in current energy systems. Since people generally perceive fossil fuels as dangerous, dirty and polluting, we expected in this scenario that stronger biospheric values would not lead to more positive evaluations of natural gas. In the second scenario, we positioned natural gas as part of future sustainable energy systems with a larger share of renewables, and indicated that in renewable energy systems, natural gas can be used as a back-up energy source when not enough energy is generated from renewable energy sources. In this way, we emphasised the association between natural gas and renewables (rather than fossil fuels) [17][cf. 17]. Because people generally perceive renewable energy sources as more sustainable than fossil fuels, sustainability claims that combine gas and renewable energy sources could potentially trigger positive evaluations among people with strong biospheric values. Yet, alternatively, in line with our reasoning above, people may still see natural gas as a fossil fuel and not evaluate it positively when they strongly endorse biospheric values, even if gas is combined with renewables. Including this scenario therefore enabled a stricter test of our reasoning. Finally, various innovative gas developments are being positioned as sustainable that do not rely on fossil fuels. Examples are so-called *green gas*, which can be produced from burning biodegradable materials and includes in a large part bio-gas, and *power-to-gas*, which entails a possibility to store energy produced from renewables in a gas system. Importantly, these new developments do not rely on fossil fuels, and thus our reasoning would imply that stronger biospheric values may lead to more positive evaluations of such gas innovations. On the other hand, however, people may still strongly associate gas innovations, in this case green gas and power-to-gas, with the fossil fuel natural gas, and as a consequence stronger biospheric values may not result in more positive evaluations of such new gas developments. Because these innovations are embedded in the gas system, but they are not fossil fuels, studying these innovations enabled us to test our reasoning in more depth.

To get more insight into the extent to which people perceive gas as sustainable, we asked respondents to evaluate the environmental consequences of gas-related activities, and we linked these evaluations to respondents' biospheric values. We expected that in the current energy systems scenario, stronger biospheric values would not lead to more positive evaluations of the environmental consequences of natural gas; if anything, stronger biospheric values may lead to more negative evaluations [15]. When gas is presented together with renewables in future energy systems, stronger biospheric values may or may not lead to more positive evaluations of the environmental consequences of gas. As explained above, this may depend on how much people's associations with renewables influence their evaluations of gas and to what extent people still see natural gas primarily as a fossil fuel; we designed the current study to find out.

2. Methods and procedure

2.1. Design and sample

We addressed the above questions in a questionnaire study in the Netherlands that was part of a larger online questionnaire study on public opinion about gas, carried out with a sample of the general Dutch population in October–December 2013. At the beginning of the survey, respondents filled in a value questionnaire, after which they evaluated natural gas. Natural gas was introduced to participants as a relatively sustainable energy source, using similar sustainability claims as commonly used in practice (see the text below). Respondents were randomly assigned to one of the two experimental conditions, where we varied the context in which natural gas was promoted as relatively sustainable. Specifically, the participants either read about gas as part of current energy systems, or as part of future energy systems with an increased share of renewables. In both conditions, we highlighted the environmental benefits of natural gas compared to other fossil fuels. Both descriptions mentioned that besides natural gas, green gas and bio-gas are part of the gas system. The crucial difference between the two conditions was that the future energy system scenario more strongly relied on renewable energy sources rather than fossil fuels. The descriptions read as follows (translated from Dutch).

Gas in current energy systems

According to experts, natural gas[1] *emits relatively less greenhouses gases, such as carbon dioxide (CO_2), than other fossil fuels, such as oil and coal. At this moment the gas system contains mainly natural gas and a small amount of green gas (the latter consists of, among others, bio-gas).*

Gas in future energy systems with increased share of renewables

According to experts, natural gas emits relatively less greenhouses gases, such as carbon dioxide (CO_2), than other fossil fuels, such as oil and coal. In the future the gas system will contain a mixture of natural gas and green gas (the latter consists of, among others, bio-gas). Gas can be used in the transition to sustainable energy systems (where wind and solar energy is used). If the wind and sun generate too little energy, the gas system can be used to meet energy demand, while a surplus of wind or solar energy can temporarily be stored in the gas system.

We also varied the study title (i.e. gas in *current* versus *future* energy systems) and the wording in the study (i.e. referring to gas either in *current* or *future* energy systems). Besides natural gas in general, participants also evaluated key gas-related activities, namely the use of gas, gas transport, and gas production. One could argue that biospheric values lead to different evaluations of natural gas, depending on whether people evaluate gas in general, or specifically the application of gas for using at home, the transport of gas, or the process of gas production; we aimed to control for such alternative explanations. Next, the participants evaluated two sustainable gas innovations, namely *green gas* and *power-to-gas*.[2]

The study was conducted via an online survey panel (www.panelinzicht.nl). In total, 510 respondents completed the questionnaire. We controlled for data quality by using two control questions in different places in the questionnaire, which requested participants to click on a specific value in the given scale; 343 respondents completed the control questions correctly. Next, we only included the responses in the analysis that were completed in no less than 10 min and no more than 90 min,[3] which resulted in the final sample size of 320 responses. As a token of appreciation for their time and effort, the 320 participants received credits worth a small amount of money. The characteristics of the sample are comparable to the Dutch population (www.cbs.nl) in terms of gender distribution and household composition, and the sample represented well the distribution of the population across different provinces in the Netherlands. While the middle age group (between 40 and 65 years) and the income group of 1000–2000 Euro net per household per month were slightly overrepresented in the sample; sample characteristics are provided in Appendix A.

2.2. Measures

2.2.1. Values

We used a validated scale to measure people's biospheric value orientation [11]. Four items represented biospheric values: respecting the earth, unity with nature, protecting the environment, and preventing pollution. Respondents rated the importance of these values "as guiding principles in their lives" on a 9-point scale ranging from −1 *opposed to my principles*, 0 *not important* to 7 *extremely important*. Respondents were asked to vary the scores and rate only few values as extremely important. Importance ratings for the cor-

[1] The Dutch term for natural gas is "aardgas", which literally means "gas from the underground".

[2] Measures in the questionnaire that are beyond the scope of this paper are not discussed here. The full questionnaire is available from the corresponding author upon request.

[3] Including responses that were completed in less or more time in the analysis led to the same conclusions in this study.

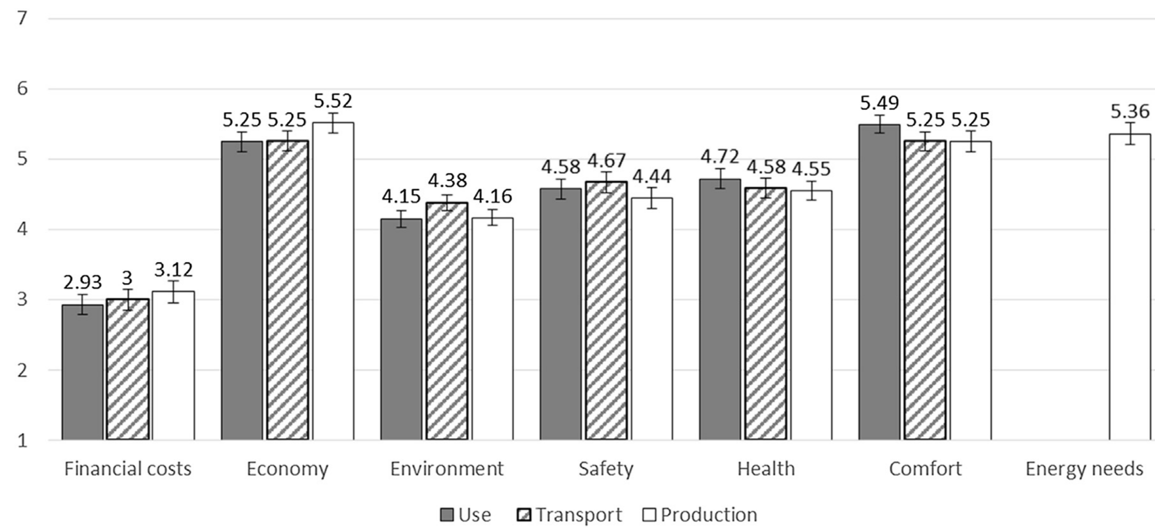

Fig. 1. Mean evaluations of the consequences of gas-related activities in the Netherlands.
Note. Consequences are listed in the same order as they were provided in the questionnaire. Error bars represent 95% confidence intervals.

responding items were averaged to form a composite scale of the biospheric value orientation ($\alpha = 0.90$, $M = 4.92$, $SD = 1.37$).

2.2.2. Evaluations of natural gas

After having read one of the descriptions of natural gas, respondents evaluated gas in the Netherlands in current or future energy systems, respectively. First, we measured overall evaluations of gas. For this purpose, respondents indicated on a 7-point scale how acceptable (1 *not at all acceptable*, 7 *very acceptable*), useful (1 *totally useless*, 7 *very useful*), good (1 *very bad*, 7 *very good*), and necessary (1 *totally not necessary*, 7 *very necessary*) they find gas in general. We computed mean scores on these items (current energy systems: $\alpha = 0.88$, $M = 5.83$, $SD = 0.99$; future energy systems: $\alpha = 0.85$, $M = 5.79$, $SD = 0.96$). Afterwards, respondents evaluated key gas-related activities on the same scales, namely the use of gas (described as *the use of gas for, for example, cooking and heating houses and water*; current energy systems: $\alpha = 0.90$, $M = 5.75$, $SD = 1.02$; future energy systems: $\alpha = 0.93$, $M = 5.78$, $SD = 0.98$), gas transport (described as *the transportation of gas from the source to the end user*; current energy systems: $\alpha = 0.94$, $M = 5.56$, $SD = 1.24$; future energy systems: $\alpha = 0.93$, $M = 5.57$, $SD = 1.10$), and gas production (described as *extracting gas from the underground and producing green gas* (*such as bio-gas*), we mentioned that the current gas system contains primarily natural gas and a small portion of green gas and that the future gas system will contain a mix of natural gas and green gas, respectively; current energy systems: $\alpha = 0.94$, $M = 5.58$, $SD = 1.17$; future energy systems: $\alpha = 0.91$, $M = 5.64$, $SD = 1.02$).

We additionally asked respondents how negative or positive they consider the environmental consequences of gas-related activities (i.e. the use of gas, gas transport, and gas production). Respondents evaluated the consequences of each gas related activity for the *quality of nature* and *climate change* on a scale ranging from *very negative* (1) to *very positive* (7), and they evaluated *environmental pollution* of each activity on a scale ranging from *very low* (1) to *very high* (7); scores on this last item were reversed coded. The mean scores on these items were computed to represent evaluations of environmental consequences of gas use (current energy systems: $\alpha = 0.78$, $M = 4.14$, $SD = 1.14$; future energy systems: $\alpha = 0.70$, $M = 4.16$, $SD = 1.04$), gas transport (current energy systems: $\alpha = 0.69$, $M = 4.41$, $SD = 1.07$; future energy systems: $\alpha = 0.70$, $M = 4.34$, $SD = 1.08$), and gas production (current energy systems: $\alpha = 0.66$, $M = 4.12$, $SD = 1.08$; future energy systems: $\alpha = 0.58$, $M = 4.21$, $SD = 1.04$; see Fig. 1 for the aggregated means across both conditions). For explorative reasons, we asked respondents to evaluate some additional consequences of gas-related activities, namely consequences for *the Dutch economy*, *safety of people in the Netherlands*, *health of people in the Netherlands*, and *daily comfort of people in the Netherlands* (on a scale ranging from *very negative* (1) to *very positive* (7)) and *financial costs for people in the Netherlands* (on a scale from *very low* (1) to *very high* (7); reversed coded). We included an additional consequence of gas production, namely *the extent to which we can meet our own energy needs by producing gas in the Netherlands (instead of importing energy from other countries)*, again evaluated on a scale ranging from *very negative* (1) to *very positive* (7) (see Fig. 1 for the aggregated means across both conditions).

2.2.3. Evaluations of gas innovations

We presented two types of innovations in the gas sector, namely *green gas* and *power-to-gas*, using similar claims as typically used in practice. This time, the descriptions were the same for all respondents, and read as follows (translated from Dutch).

Green gas *consists of, among others, bio-gas. Bio-gas is produced from, among others, sludge, garden waste, (waste from) vegetables, fruit, and plants, animal waste (e.g. cow manure) and waste from landfills. Green gas has the same quality as natural gas and can be used in the same way.*

Power-to-gas *entails that electricity generated from wind and solar energy is converted to gas, so that it can be stored for later use. This means that wind and solar energy can be used when the wind is not blowing or the sun is not shining.*

Respondents evaluated green gas and power-to-gas on a 7-points scale on a range of characteristics, some of which were related to the fact that these are innovative developments aimed at sustainable transitions: *very negative–very positive*, *not at all acceptable–very acceptable*, *not at all sustainable–very sustainable*, *not at all useful in transition to renewable energy–very useful in transition to renewable energy*, and *not at all important to invest in–very important to invest in*. The means scores on these items were computed to represent evaluations for green gas ($\alpha = 0.94$, $M = 5.63$, $SD = 1.14$) and power-to-gas ($\alpha = 0.98$, $M = 5.43$, $SD = 1.35$).

We conducted multivariate analyses of variance to test our hypotheses [24]. Multivariate analysis of variance enables us to test whether evaluations of gas in general and gas related-activities differ depending on the strength of people's biospheric values, and whether values have different effects on these evaluations across the two experimental conditions. Since context manipulation (i.e. current versus future energy systems) did not apply to descriptions of gas innovations, we used multivariate analysis to only study the effects of biospheric values on evaluations of these innovations. Multivariate analysis of variance controls for the fact that multiple comparisons for several dependent variables (i.e. evaluations of gas in general and of different gas-related activities, evaluations of green gas and power-to-gas) are made. We therefore considered it more adequate than conducting multiple univariate analyses for each dependent variable separately. As biospheric value orientation is a continuous variable, we included it as a covariate in the analyses, and hence conducted multivariate analyses of covariance (MANCOVA's).

3. Results

3.1. Evaluations of natural gas

Our main question is how overall evaluations of gas, which is positioned as sustainable, are related to people's biospheric values. To test this, we conducted MANCOVA with values as a covariate and current versus future context as a predictor factor. Pillai's trace showed no significant main effect of biospheric values, $V = 0.004$, $F(4, 313) = 0.29$, $p = 0.89$. Also, overall evaluations of gas and gas-related activities did not differ significantly depending on whether gas was presented as a part of current energy systems or future energy systems with renewables, $V = 0.007$, $F(4, 313) = 0.54$, $p = 0.71$. Furthermore, the relationships between biospheric values and overall evaluations of gas and gas-related activities did not differ significantly across the two context conditions, since there was no significant interaction effect, $V = 0.006$, $F(4, 313) = 0.47$, $p = 0.76$.

Next, we looked in more depth how people evaluate the environmental sustainability of natural gas. The environmental consequences of gas use, transport, and production were not evaluated very positively, but also not very negatively; Fig. 1 shows the aggregated means across both conditions. We conducted MANCOVA to test whether evaluations of environmental consequences of gas-related activities differ depending on biospheric values and across the current versus future context conditions. Pillai's trace showed a significant main effect of biospheric values, $V = 0.05$, $F(3, 314) = 5.40$, $p = 0.001$, $\eta p^2 = 0.05$. Follow-up analyses in MANCOVA revealed that the effects of values were significant for evaluations of environmental consequences of all gas-related activities (gas use: $F(1, 316) = 13.76$, $p < 0.001$, $\eta p^2 = 0.04$; gas transport, $F(1, 316) = 11.48$, $p = 0.001$, $\eta p^2 = 0.04$; gas production, $F(1, 316) = 13.03$, $p < 0.001$, $\eta p^2 = 0.04$). Sustainability claims indeed did not result in positive evaluations of environmental consequences of gas among people with strong biospheric values. In fact, the stronger their biospheric values, the more negatively respondents evaluated the environmental consequences of gas use, $b = -0.18$, $p = 0.002$, gas transport, $b = -0.13$, $p = 0.03$, and gas production, $b = -0.15$, $p = 0.01$. Evaluations of environmental consequences of gas-related activities did not differ significantly across the two experimental conditions, $V = 0.005$, $F(3, 314) = 0.50$, $p = 0.68$, and there was no significant interaction effect of biospheric values and the context manipulation, $V = 0.003$, $F(3, 314) = 0.34$, $p = 0.80$.

Additional analyses revealed that respondents evaluated the consequences of gas-related activities for the Dutch economy and for the daily comfort of people in the Netherlands rather positively. Also the extent to which gas production contributes to meeting the energy demand of people in the Netherlands was evaluated rather positively. The financial costs of gas-related activities were evaluated relatively negatively. The consequences for health and safety of people in the Netherlands were not evaluated very positively nor very negatively.

3.2. Evaluations of gas innovations

Evaluations of gas innovations, namely green gas and power-to-gas, were above the mid-point of the scale and thus rather positive. Since the context manipulation was not included here, we conducted one MANCOVA analysis with the biospheric value orientation as predictor. The analysis showed a significant effect of biospheric values on evaluations of these innovations, $V = 0.17$, $F(2, 317) = 33.32$, $p < 0.001$, $\eta p^2 = 0.17$. Follow-up analyses in MANCOVA revealed that the effects of values were significant for evaluations of both green gas, $F(1, 318) = 64.45$, $p < 0.001$, $\eta p^2 = 0.17$, and power-to-gas, $F(1, 318) = 19.66$, $p < 0.001$, $\eta p^2 = 0.06$. The stronger their biospheric values, the more positively respondents evaluated green gas ($b = 0.34$, $p < 0.001$) and power-to-gas ($b = 0.24$, $p < 0.001$).

4. Discussion

Various energy developments are being promoted as environmentally sustainable. Yet, the role they will play in sustainable energy futures depends largely on public support. Sustainability claims stress that an energy development has less detrimental consequences for nature and the environment, for example when compared to other energy developments, and therefore can facilitate sustainable energy transitions. Such sustainability claims are likely to be particularly considered by people who care about nature and the environment, that is, who strongly endorse biospheric values. Value theory suggests that people evaluate energy developments positively when these developments support their important values, and negatively when these developments threaten their important values [4,6,7]. Yet, we proposed in this paper that sustainability claims are not a simple panacea and that stronger biospheric values may not lead to more positive evaluations of every energy development that is promoted as sustainable. We hypothesized that stronger biospheric values would not lead to more positive evaluations of fossil fuels, particularly natural gas, despite the sustainability claims, as fossil fuels are not evaluated as sustainable in the first place. Indeed, we did not find positive (nor negative) relationships between biospheric values and evaluations of natural gas when gas was promoted as a relatively sustainable energy source. This was not only the case when natural gas was described as a part of current energy systems, but also when natural gas was described as a transition fuel towards future sustainable energy systems with an increased share of renewables. Thus, even when combined with renewables, natural gas is probably still seen primarily as a fossil fuel, and as a consequence stronger biospheric values do not lead to more positive evaluations. Further analyses showed that the environmental consequences of natural gas were evaluated as rather neutral, that is, not very positively nor very negatively. This suggests, first, that sustainability claims did not result in very positive evaluations of the environmental consequences of gas, and second, that such perceived neutral environmental consequences were not sufficient to trigger positive evaluations for people with strong biospheric values. In fact, the results suggest that particularly people with strong biospheric values may be least convinced by sustainability claims about fossil fuels, since we found that stronger biospheric values led to more negative evaluations of the environmental consequences of natural gas when gas was promoted as sustainable.

Interestingly, when innovative gas developments were introduced (i.e. green gas and power-to-gas), stronger biospheric values were related to more positive evaluations of these innovations. Overall, these findings suggest that sustainability claims can elicit positive evaluations among people with strong biospheric values when energy developments do not rely on fossil fuels, while sustainability claims will not trigger such positive evaluations among those who strongly endorse biospheric values when energy developments rely on fossil fuels. Although the current study was conducted in the Dutch context, we study the general psychological factors (i.e. values) and processes that could be applied in understanding public evaluations of various energy developments across various (cultural) contexts.

A recent study in the UK on shale gas also suggests that people who strongly care about the environment may actually be less rather than more convinced by sustainability claims [25]. The study revealed that most respondents were ambiguous about whether energy from shale gas would substantially reduce CO_2 emissions, and whether shale gas is a clean energy source; that is, they neither agreed nor disagreed with these statements [25]. The more people thought about themselves as someone who is concerned about the environment and the more they thought that being environmentally-friendly is an important part of who they are (i.e. conceptualized in this paper as environmental identity), the less they evaluated shale gas as a clean energy source, and this relationship remained even after providing information about the potential environmental benefits of shale gas. Notably, the environmental consequences of natural gas and shale gas are not evaluated very negatively: respondents evaluated the environmental consequences of natural gas as rather neutral in the current study and people were rather ambiguous about the environmental consequences of shale gas in the study in the UK [25]. Still, probably the fact that these energy sources are fossil fuels already mean that stronger biospheric values do not lead to more positive evaluations of these energy sources.

Together, the current findings and the findings from the study in the UK discussed above have important implications for energy policy. Natural gas and unconventional forms of oil and gas have been promoted as transition fuels facilitating sustainable energy transitions. Despite sustainability claims, however, these energy sources may not be seen as "sustainable enough" to trigger positive evaluations for people with strong biospheric values, probably because these energy sources are fossil fuels. As long as people do not evaluate energy sources as sustainable, sustainability claims may not trigger positive evaluations for people who strongly care about the environment. We argue that for energy policy, it is crucial to be aware of which key concerns underlie people's evaluations of energy developments and why strong biospheric values do not lead to positive evaluations of certain energy developments that are promoted as sustainable. Truly sustainable energy developments should address people's key concerns and should be actually seen by people as sustainable, rather than only being promoted as such. For this purpose, close integration of social sciences in energy research is required [3,26]. In this respect, future research could study other important psychological factors and processes, next to values. For example, trust in involved parties could influence credibility of sustainability claims and, more generally, the evaluations of energy developments [see [8,27] for reviews].

4.1. Limitations and future research

We assumed in this study that people do not perceive gas as very sustainable and we predicted that biospheric values would therefore not lead to more positive evaluations of gas, which was supported by the findings. We did not study, however, how people come up with their evaluations of sustainability of gas in the first place. So the question remains why people do not evaluate natural gas as a (very) sustainable energy source. For example, people may not see gas as sustainable because they think it emits too much CO_2, but also because they associate gas production with safety hazards. The latter is particularly relevant given that gas production in the Netherlands has been much debated due to induced earthquakes [28]. Similarly, unconventional oil and gas developments may be associated with various hazards, such as ground water contamination, contribution to water scarcity, and seismic activity, which could influence people's evaluations of the sustainability of these developments on many different environmental aspects [20,21]. Future studies could explore how people develop their evaluations of sustainability of energy developments and which (perceived) consequences of energy developments play a key role in these evaluations. Shale gas is in fact natural gas, but it requires a different production method to extract it from shale formations (i.e. hydraulic fracturing). Future studies could look at the extent to which people perceive natural gas and shale gas differently, and how these perceptions are related to their evaluations of the different production methods.

Gas, and particularly the distinction between natural gas and gas innovations, was a very relevant case in point for testing our theoretical reasoning. Specifically, we chose an energy development that is promoted as sustainable, but that could potentially not be perceived as such by people, and we tested the relationship between people's biospheric values and their evaluations of such an energy development. Yet, studying an existing energy development brought limitations to the current design. For example, since gas is being promoted as sustainable in the Netherlands, we chose to not include a condition without such claims, since everyone may be familiar with these claims already. We therefore did not compare value-driven evaluations of gas without sustainability claims versus with sustainability claims. Additionally, adding information about renewable energy sources made the text in the future energy systems scenario longer than in the current energy systems scenario, which may potentially have affected our results. Yet, most importantly for the current reasoning, we found that even when gas was profiled together with renewables, stronger biospheric values did not lead to more positive evaluations. Future studies could address these limitations, for example by introducing hypothetical energy developments (i.e. scenario studies) and experimentally manipulating the various consequences of these developments and different types of sustainability claims, including the control condition without sustainability claims. Additionally, it would be interesting to monitor the relationships between values and evaluations of energy developments over a longer period of time, to see whether and how these relationships change, for example due to major events (e.g. accidents) and discussions about various consequences of these developments in the media and in public and policy debate. Finally, we encourage testing the current reasoning for various energy developments across different countries to test the generalizability of our findings.

Biospheric values explained a modest amount of variance in evaluations of gas innovations. This is in line with previous findings that values explain a relatively small amount of variance in specific attitudes, beliefs, and behaviours [see [6,7] for reviews]. Values are general constructs, reflecting people's goals and ideals in life, and therefore may not be very predictive of evaluations of specific objects. Yet, particularly because values reflect general goals, they are very important to consider in research on public evaluations of many different energy sources, systems, and policies [4,7]. Indeed, studies on different energy developments, including the current study, show that values may underlie people's evaluations of these developments [see [4,8] for reviews]. The effects of values on evaluations of energy developments are likely to be mediated by other constructs that are more proximate to and hence more predictive of these evaluations, such as beliefs, norms, and environmental identity. Future studies need to test under which conditions values are most predictive of evaluations of different energy developments and which are the key mediating factors. Related to that, more experimental studies could be carried out in the future. Given the correlational design, we were not able to study the extent to which the perceived environmental consequences of natural gas influenced the overall evaluations of gas or, the other way around, to what extent people may have adjusted their evaluations of specific consequences based on their general judgements of gas, and how it depends on people's biospheric values [12,15]. Experimental studies could clarify these relationships, for example, by systematically manipulating how much information people have about certain consequences of energy developments.

5. Conclusion

An important part of sustainable energy transitions is adoption and use of sustainable energy developments on a wide scale in society. Different energy developments are positioned as sustainable, yet they trigger different evaluations in people, which affects public support for these developments. We argued that although people may strongly endorse biospheric values, this does not mean that they will favour every energy development that is positioned as sustainable. Sustainability claims need to be in line with people's intuitive associations and be credible for a given energy development. In fact, people with strong biospheric values may be most critical and most demanding when it comes to the environmental consequences of energy developments, and not easily convinced by merely sustainability claims.

Acknowledgements

The empirical study was conducted within the project "Acceptability of gas as future energy source" (in Dutch: "Acceptatie van gas als energiebron voor de toekomst"), funded by the Dutch government via the Top Consortium for Knowledge and Innovation on Gas (in Dutch: TKI Gas, Topconsortia voor Kennis en Innovatie Gas, www.tki-gas.nl), ref. no. TKIG01016, and co-funded by the European gas infrastructure company Gasunie. The research team was responsible for designing and conducting the study, and for analysing and reporting the results. The Gasunie provided input when building the experimental scenarios, in order to reflect the actual sustainability claims for gas that are being used in practice. In all research phases, including collaboration with public and private parties, the Dutch Code for Academic Integrity (the Association of Universities in the Netherlands, 2014) and the European Code of Conduct for Research Integrity (European Science Foundation, 2011) were carefully followed.

The authors thank Chris Glerum (Gasunie, the Netherlands) for feedback when designing the study and preparing the manuscript.

The authors thank Casper Albers (University of Groningen, the Netherlands) for advice regarding the statistical analysis.

The authors thank Elliot Sharpe (Nottingham Trent University, United Kingdom) for proofreading the manuscript and making language suggestions.

Appendix A. Sample characteristics (*N* = 320).

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Gender:	M 171, F 149
Age:	M = 52.77 (SD = 10.93) Min = 19, Max = 77
Highest completed education:	
Lower (primary school, lower vocational training)	13.8%
Middle (medium level secondary education, medium vocational training)	38.7%
Higher (higher level secondary education, higher vocational training)	39.7%
Scientific education (university)	7.8%
Living situation:	
Alone	24.7%
Alone with children	7.5%
With a partner	38.8%
With a partner and children	25%
With other people (e.g. students, residential community)	.3%
Other	3.8%
Household income (net per month):	
<€1000	8.8%
€1000–€2000	40%
€2000–€3000	29.7%
€3000–€4000	12.8%
€4000–€5000	4.7%
>€5000	1.6%
Missing values	2.5%

Note. We additionally documented participants' postal codes. Sample distribution represented well the distribution of the Dutch population across the different provinces in the Netherlands.

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